# United States Patent [19]

**Turra et al.**

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[54] **DEVICE FOR CHECKING CONDITIONS OF A STRIP OF WRAPPING MATERIAL TO A USER MACHINE**


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[73] Assignee: **G.D. S.p.A.,** Bologna, Italy



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[51] **Int. Cl.**[5] ..... **G01J 1/32;** G01N 21/86

[52] **U.S. Cl.** ..... **250/205;** 250/561

[58] **Field of Search** ..... 250/561, 562, 571, 572, 250/563, 205; 356/429, 430; 131/905, 906



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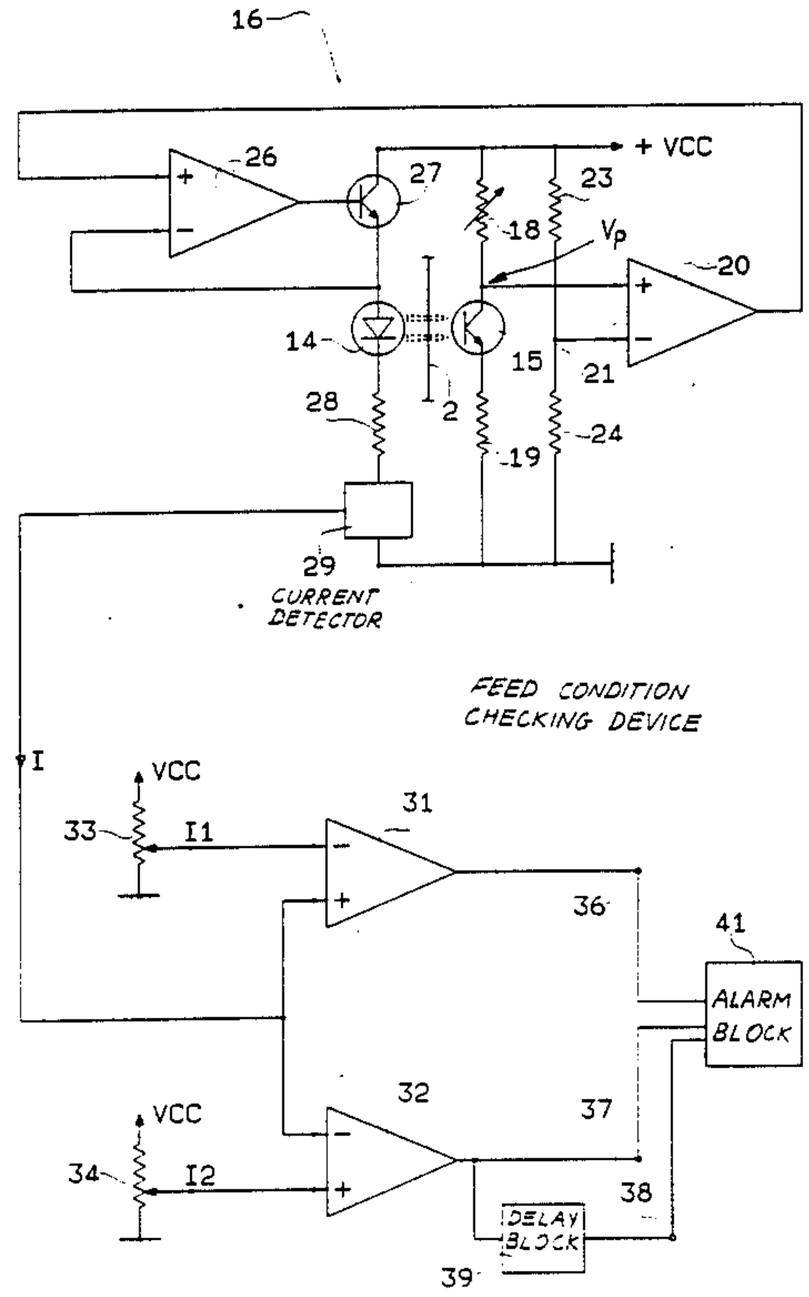
[57] **ABSTRACT**

The device for checking the feed conditions of a strip of wrapping material comprises a photodiode and a phototransistor arranged on opposite sides of the strip. A circuit block including a negative feedback is connected between the phototransistor and the photodiode to cause the phototransistor to work in a linear manner. The circuit block comprises an amplifier for amplifying the output signal of phototransistor to feed a check signal to the photodiode and to obtain from said photodiode a signal indicating anomaly conditions in the feed of the strip.


**9 Claims, 2 Drawing Sheets**



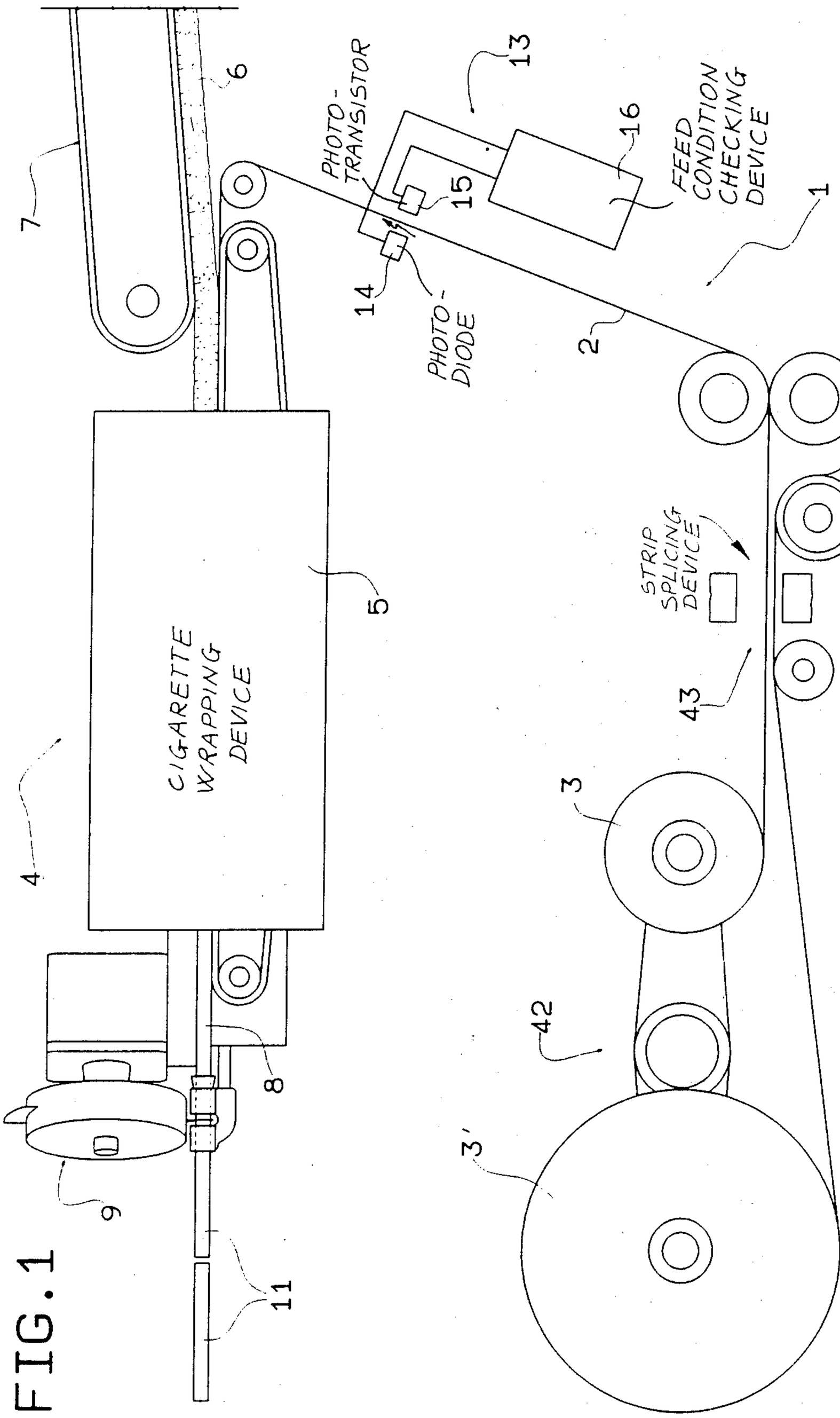
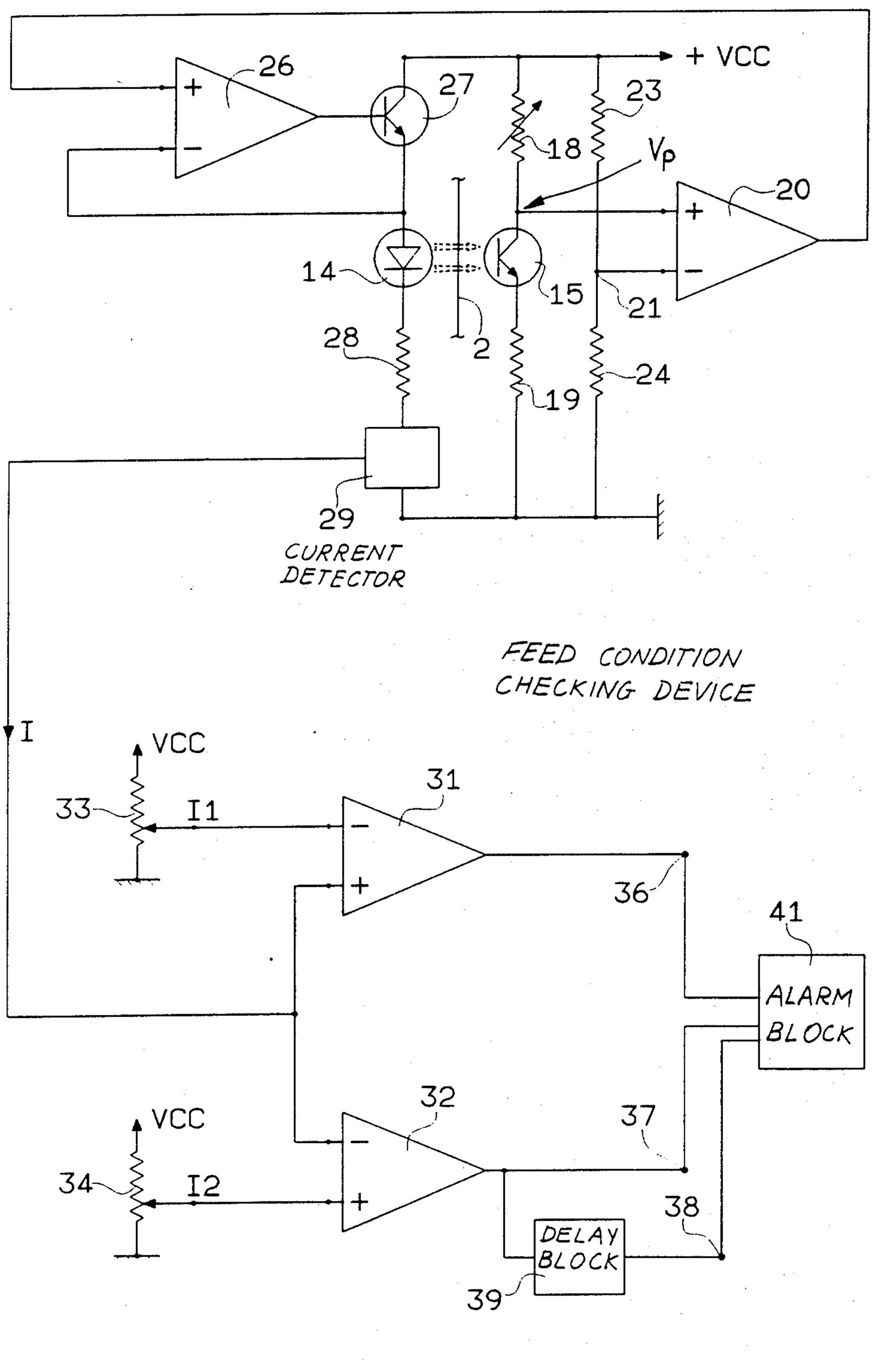

6
7
PHOTO-TRANSISTOR
13
16
FEED CONDITION CHECKING DEVICE
15
1
14
PHOTO-DIODE
2
5
CIGARETTE WRAPPING DEVICE
STRIP SPLICING DEVICE
43
3
4
42
8
3'
9
11

FIG. 1

FIG. 2


16
+ VCC
26
27
23
18
Vp
20
14
15
21
2
28
24
19
29
CURRENT DETECTOR
FEED CONDITION CHECKING DEVICE
I
VCC
33
I1
31
36
41
ALARM BLOCK
32
37
VCC
34
I2
38
DELAY BLOCK
39

# DEVICE FOR CHECKING CONDITIONS OF A STRIP OF WRAPPING MATERIAL TO A USER MACHINE

## BACKGROUND OF THE INVENTION

The present invention relates to a device for checking the conditions of the feed of a strip of wrapping material to a user machine, and more in particular it relates to an apparatus for feeding a strip of cigarette paper in a cigarette manufacturing machine.

As known, the checking devices of these machines are capable of detecting interruptions in the feed, e.g. as a consequence of the breakage of the paper strip, using a light-emitting element arranged to one side of the strip and a light-detecting element arranged to the opposite side; depending on the intensity of the light reaching the detector element, constituted e.g. by a phototransistor, the latter either conducts or is switched off, so as to provide information regarding any breakage of the strip.

It is therefore sufficient to check whether current flows in the output circuit of the phototransistor to acquire information about the presence or absence of the strip.

There are also other checking devices which are capable of detecting incorrect feed conditions, such as e.g. portions of tape having an irregular thickness as a consequence of a splicing of the terminal portion of a strip unwound from an almost empty reel with the initial portion of a strip unwound from a new reel.

Regarding the detection of such splices between the two strips, arising from reel changing operations, such splices area also detected by similar optical devices in order to be eliminated; the passage of a spliced portion at a checking device in fact completely cuts off the beam of light which filters through the paper strip in normal operating conditions.

In the known art, the above described optical detection devices are used in practice in the two alternative conducting and switched off conditions in order to maximize their reliability.

This however entails the use of separate checking devices to detect different conditions of anomalies in strip feed, and the sensitivity of the detector elements may furthermore vary as the local lighting conditions vary.

## SUMMARY OF THE INVENTION

The aim of the present invention is to provide a single checking device which is capable of detecting the various anomalies, including interruptions in the feed of the strip of wrapping material due to breakages or to depletion of the reel, and regions of splicing of two strips due to the replacement of a depleted reel with a new reel, with maximum reliability.

An object of the present invention is to provide a device of the above described type which is capable of performing a self-diagnostics operation for the malfunctions of its components.

The above-mentioned aim and objects, and other objects which will become apparent hereinafter, are achieved by a device for checking the feed conditions of a strip of wrapping material to a user machine as defined in claim **1**.

The present invention provides a device for checking the feed conditions of a strip of wrapping material, characterized in that it comprises light-emitting means and means for detecting the emitted light, arranged on opposite sides of said strip, circuit means adapted to make said detector means operate in a linear manner, by generating an output signal which is proportional to the detected light, said circuit means comprising means for amplifying said output signal, to provide a check signal to said light-emitting means and to obtain a signal indicating anomaly conditions in the feed of said strip.



## BRIEF DESCRIPTION OF THE DRAWINGS

The invention is now described with reference to the accompanying drawings, which illustrate a preferred but nonlimitative embodiment, wherein: FIG. **1** is a schematic view of a cigarette manufacturing machine comprising the checking device according to the present invention; and FIG. **2** is a view of the electric circuit of the checking device of FIG. **1**.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIG. **1**, the reference numeral **1** generally indicates an apparatus for feeding a strip of wrapping material **2**, unwound from a reel **3** and fed, through known reel-changing and splicing devices, respectively **42** and **43**, to a user machine constituted by a cigarette manufacturing machine **4**.

Said machine **4** comprises a device **5** for wrapping a continuous strip or line of tobacco **6** which is fed by conveyor means **7** within the strip of wrapping material **2** so as to form a continuous cigarette **8** which is divided into individual cigarettes **11** by a rotary-blade device **9**.

The reference numeral **13** generally indicates a device for checking the feed conditions of the strip **2** to the machine **4**.

Said device **13** comprises a light-emitting element **14** arranged to one side of the strip **2** and a light-detecting element **15** arranged on the opposite side. both connected to circuit block **16**.

With reference also to FIG. **2**, the light-emitting element **14** is constituted by a photodiode, while the detecting element **15** is constituted by a phototransistor. The collector of the phototransistor **15** is connected through a potentiometer **18** to a positive supply voltage +VCC. The emitter of the phototransistor **15** is connected to the ground by means of a resistor **19**.

The reference numeral **20** indicates a two-input amplifier having a first positive input directly connected to the collector of the phototransistor **15**, and a second negative input is connected to a terminal **21** which is connected to the positive power supply +VCC by means of a resistor **23**, and is connected to the ground by means of a resistor **24** which is equal in value to the resistor **23**. The resistors **23** and **24** constitute therefore a voltage divider which determines a voltage on the terminal **21** which is approximately half the voltage existing on the positive pole +VCC.

The output of the amplifier **20** is connected to a first (positive) input of a two-input amplifier **26** which constitutes a voltage-current converter the ouput whereof is connected to the base of an NPN transistor **27** which acts as power amplifier.

The collector of the transistor **27** is directly connected to the positive power supply +VCC and its emitter is connected to a second (negative) input of the amplifier **26** and to the anode of the photodiode **14**, the cathode whereof is connected to the ground by means of a resistor **28** and a block **29** which provides an output

signal I which is proportional to the current which flows through the photodiode **14**.

Said signal I is sent to discriminating means comprising two comparators **31** and **32**. More precisely, said signal I reaches the positive input of the comparator **31** and the negative input of the comparator **32**. At the negative input of the comparator **31** there is a signal **I1** determined by means of a potentiometer **33**, and at the positive input of the comparator **32** there is a signal **I2** determined by means of a potentiometer **34**. The value of the signal **I2** is higher than the value of the signal **I1**, and they are set as limits of the range of values which the signal I can assume in conditions of normal feed of the strip **2**. Said comparators **31** and **32** therefore constitute, as a whole, a window comparator group. The output of the comparator **31** is connected to a terminal **36**, while the output of the comparator **32** is directly connected to a terminal **37** and to a terminal **38** through a block **39** which provides a signal in output when the signal at its input persists longer than a preset time. Said terminals **36**, **37** and **38** are connected to an alarm indicator block **41**.

The operation of the checking device **13** according to the present invention is as follows.

Considering the apparatus **1** during the normal feed of the strip **2** to the cigarette manufacturing machine **4**, the checking device **13**, with the strip **2** between the phototransistor **15** and the photodiode **14**, is calibrated by adjusting the potentiometer **18** so as to have a set voltage VP on the collector of the phototransistor **15**; the value of said voltage VP is substantially intermediate between the value of the saturation voltage VS and the value of the switch-off voltage VI and is in particular proximate to the value of the voltage at the node **21**.

In this manner the phototransistor **15** operates in a linear manner, with the output voltage signal VP on the collector being proportional to the amount of light detected by the phototransistor itself. For this collector voltage value VP there is a current, as a function of the amplification coefficents of the amplifiers **20** and **26** and of the transistor **27**, which flows through the photodiode **14** so that the derived current I is intermediate between the two current values **I1** and **I2** respectively present at the two complementary inputs of the comparators **31** and **32**. Consequently there is a signal with a logical level **1** at both output terminals **36** and **37**, so that the alarm block **41** and the block **39** are not activated.

Assume now that there is an interruption in the passage of the strip **2** between the phototransistor **15** and the photodiode **14**, e.g. due to a breakage of the strip **2** or to the absence of said strip for any reason (e.g. the reel **3** has emptied and the device **43** has not spliced the strip of the reel **3'**). This produces an increase in the intensity of the light which reaches the phototransistor **15** and a corresponding increase in the emitter-collector current; this causes therefore a decrease in the voltage VP present at the positive input of the amplifier **20**. A decrease in the current which flows through the photodiode **14** is obtained through the amplifiers **20** and **26** and the transistor **27**; this is equivalent to a decrease in the intensity of the light which reaches the phototransistor **15** so as to increase the voltage on the collector of the phototransistor **15** towards the normal operating value VP, i.e. in the proportional operating range.

The decrease in the current flowing through the photodiode **14** determines a reduction in the current I, so as to drop below the value **I1**, so that the signal at the output of the comparator **31** changes state; said comparator determines a visual or acoustic signal capable of attracting the attention of an operator by means of the block **41**, and said operator can restore the correct conditions for the feed of the strip **2**.

Secondly, assume that due to a splicing (performed by means of the known device **43**) between the end portion of a strip **2** unwound from an almost empty reel **3** and the initial portion of a new reel **3'** a portion of strip with double thickness runs between the phototransistor **15** and the photodiode **14**. This causes a decrease in the intensity of the light received by the phototransistor **15** and a corresponding decrease in the related emitter-collector current.

In this situation, the voltage present at the positive input of the amplifier **20** increases, so that, the current flowing through the photodiode **14** increases. This is equivalent to an increase in the intensity of the light received by the phototransistor **15**, and consequently to a decrease in the voltage on the collector of the phototransistor **15** towards the normal operating value VP.

The increase in the current flowing through the photodiode **14** determines an increase in the current I which is greater than the value of the signal **I2**, so that the signal at the output of the comparator **32** changes state and a signal indicating the anomaly is fed to the block **41** through the terminal **37** and allows e.g. to discard said portion of douoble-thickness strip **2** in the manufacturing machine **4**. If the portion with double thickness is too long, then the indication signal at the output of the comparator **32** persists longer than a preset limit value and is detected by the block **39**, which provides the block **41** with a signal for a consequent alarm, which provides the block **41** with a signal for a consequent alarm. Said alarm signal furthermore occurs if, due to any circuit malfunction of the device **13**, the anomaly signal of the comparator **32** is stably present.

The advantages obtained with the checking device according to the present invention are evident from what has been described.

In particular the detection of various anomaly conditions of the strip feed is achieved with a single pair of light-emitting and light-detecting elements by virtue of the fact that the light-detecting element does not operate in saturation or switched off conditions but operates in a linear manner with the output signal being proportional to the amount of detected light. This also determines high sensitivity of the checking functions, which is also increased by the fact that the anomaly detection is not performed by directly detecting the output signal of the light-detecting element but by means of a final element of an amplifier unit which particularly checks the light-emitting element in negative feedback.

The block **39** furthermore performs auto-diagnostics functions for the functionality of the device **13**.

Finally, it is evident that the described and illustrated embodiment of the control device according to the present invention is susceptible to modifications and variations without abandoning the scope of the inventive concept.

For example, the photodiode **14** and the phototransistor **15** may be replaced with functionally equivalent elements.

We claim:

**1**. A device for checking feed conditions of a continuous strip of wrapping material, comprising an optoelectronic device including a light-emitting means and a light-detecting means, arranged on opposite sides of said continuous strip, a negative feedback circuit means

connected between said light detecting means and said light emitting means for causing said optoelectronic device to operate in a linear manner, current detecting means connected in series with said light emitting means and generating an output signal correlated to a current flowing through said light emitting means, and means for detecting interruptions and thickened portions of the continuous strip according to the amplitude of said output signal, said means for detecting being connected to said current detecting means and receiving said output signal therefrom.

**2**. A device according to claim **1**, wherein said means for detecting comprises means for comparing said output signal to at least two reference signals.

**3**. A device acording to claim **2**, wherein said means for detecting further comprises delay means for detecting the presence of thickened portions of the continuous strip for longer than a preset time and alarm devices.

**4**. A device according to claim **1**, wherein said means for detecting comprises at least one window comparator.

**5**. A device according to claim **1**, wherein said negative feedback circuit means comprises an amplifier means connected to said light detecting means and generating an amplified signal, and driver means connected between said amplifier means and said light emitting means, said driver means receiving said amplified signal and generating a corresponding driving signal for said light emitting means.

**6**. A device according to claim **5**, wherein said light emitting means is a photodiode having an anode and said light detecting means is a phototransistor having emitter and collector terminals each connected to a respective one of two reference potential lines through respective resistor means, said amplifier means including a two input amplifier having a positive input connected to said collector terminal of said phototransistor, a negative input connected to a reference voltage signal and an output connected to said driver means, said driver means including a voltage-current converter and a power amplifier transistor, said voltage-current converter having a converter input connected to said output of said two input amplifier and a converter output and said power amplifier transistor having a base terminal connected to said converter output, a collector terminal connected to one of said reference potential lines and an emitter terminal connected to said anode of said photodiode.

**7**. A device according to claim **6**, wherein at least one of said respective resistor means comprise a variable resistor and said negative input of said two input amplifier is connected to the intermediate tap of a resistive voltage divider connected between said two reference potential lines.

**8**. A device for checking feed conditions of a continuous strip of wrapping material, comprising:

an optoelectronic device including a photodiode having a cathode and an anode and a phototransistor having emitter and collector terminals, said photodiode and phototransistor being arranged on opposite sides of said continuous strip and being each connected to a respective one of two reference potential lines through respective resistor means;

a negative feedback circuit means controlling said optoelectronic device to operate in a linear manner, said negative feedback circuit means comprising a two input amplifier, a voltage-current converter and a power amplifier transistor,

said two-input amplifier having a positive input connected to said collector terminal of said phototransistor, a negative input connected to a reference voltage signal and an output,

said voltage-current converter having a converter input connected to said output of said two input amplifier and a converter output and

said power amplifier transistor having a base terminal connected to said converter output, a collector terminal connected to one of said reference potential lines and an emitter terminal connected to said anode of said photodiode;

current detecting means connected in series with said photodiode and generating an output signal correlated to a current flowing through said photodiode, and

means for detecting interruptions and thickened portions of the continuous strip according to the amplitude of said output signal, said means for detecting being connected to said current detecting means and comprising means for comparing said output signal to at least two reference signals.

**9**. In a cigarette manufacturing machine, an apparatus for feeding a continuous strip of cigarette paper comprising, cascade coupled to each other: at least two feed reels feeding strips of cigarette paper; a strip splicing device, for splicing said strips of cigarette paper into a continuous strip; a feed condition checking device, for detecting interruptions and thickened portions of said continuous strip; a cigarette wrapping device and blade means for cutting individual cigarettes, said feed condition checking device comprising an optoelectronic device including a light-emitting means and a light-detecting means, arranged on opposite sides of said continuous strip, a negative feedback circuit means connected between said light detecting means and said light emitting means for causing said optoelectronic device to operate in a linear manner, current detecting means connected in series with said light emitting means and generating an output signal correlated to a current flowing through said light emitting means, and means for detecting interruptions and thickened portions of the continuous strip according to the amplitude of said output signal.

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